TERRA-MED PhD PROGRAM - Marie Skłodowska-Curie Actions

Context on the program

TERRA-MED is an interregional doctoral program funded under the Marie Skłodowska-Curie COFUND Actions that will recruit and train a new generation of researchers to address the sustainability and resource stress (Water–Land–Energy nexus) in Mediterranean territories.



The Euroregion Pyrenees–Mediterranean, coordinator of the program, brings together the Regions of Occitanie (France), Catalonia and the Balearic Islands (Spain) forming a cross-border research ecosystem. Through this collaboration, TERRA-MED connects world-class universities, research centres and socio-economic actors committed to advancing resilience in the face of climate change. With more than 22,000 scientists across 10 universities and 2 research centers, encompassing 1000 research units, TERRA-MED provides a rich, interdisciplinary environment where doctoral candidates can excel and launch their research careers.

33 PhD positions will be offered to early-stage researchers with a unique interregional, interdisciplinary and intersectoral environment.

Fellows will benefit from having two supervisors (a principal supervisor and a co-supervisor) from two different regions and having a non-academic mentor. The fellows will undertake mandatory cross-border or international stays to the co-institution, as well as a secondment in a non-academic entity.

Moreover, doctoral candidates will receive a specifically designed training program related to their research topics, alongside modules on innovation, entrepreneurship, project management, ethics, open science, etc.

Benefits of TERRA-MED PhD program

- Top-tier PhD education and research training
- Access to world-class laboratories
- Interregional double supervision
- Double PhD degree (France / Spain) where applicable
- Interdisciplinary and cross-sector research experience
- Unique TERRA-MED's excellence training program on resources stress and climate change. See here
- Attractive salary in the frame of MSCA standards
- Extensive network of academic and non-academic partners
- 2 secondments: 1 in the co-supervisor's institution (9 to 12 months); 1 in a non-academic organization to gain extra academic experience and skills (3 to 6 months)

Reference of the thesis project: **CRG1**	**Title of the thesis project** **From diversity to function: deciphering the activity and interactions of microbial eukaryotes in aquatic ecosystems**

Host institution: Centre for Genomic Regulation (CRG)	**Co-supervision / co-host institution:** University of Montpellier
Country: Spain	**Country:** France
Host Research Unit: Sebe-Pedros Lab, CRG. The group studies single-cell genomics, biodiversity, phylogenetics, epigenetics and evolutionary biology. It develops and applies single-cell transcriptomics to non-model organisms and has access to liquid-handling robotics, advanced flow cytometry and image-based cell sorting, long-read sequencing, and high-performance computing.	**Co-host Research Unit:** MARBEC, University of Montpellier. The co-host contributes complementary expertise in aquatic microbial ecology, environmental observation, field sampling and ecological interpretation, connecting molecular measurements with real marine ecosystems and environmental gradients.
Name of the first co-supervisor Arnau Sebe-Pedros - Sebe-Pedros Lab, arnau.sebe@crg.eu	**Name of the second co-supervisor** Francesca Vidussi Mostajir MARBEC, francesca.vidussi@cnrs.fr
Doctoral School: Pompeu Fabra University (UPF)	**Doctoral School:** University of Montpellier

Research field(s)

Single-cell genomics; aquatic microbial ecology; environmental genomics; biodiversity; phylogenetics; bioinformatics and computational biology

Keywords

Biomonitoring; protists; single-cell transcriptomics; symbiosis; aquatic ecosystems; computational biology; climate resilience

Description of the research project

This PhD will combine single-cell transcriptomics, bioinformatics and aquatic microbial ecology to develop new ways of measuring not only which microbial eukaryotes are present in aquatic ecosystems, but also what they are doing and how they interact.

Context and Rationale:

Scientific Context:

Microbial eukaryotes, commonly referred to as protists, are among the most diverse and functionally versatile organisms in aquatic environments. They include photosynthetic primary producers, predators, parasites and symbiotic partners, and they occupy key positions in marine and freshwater food webs. Through photosynthesis, grazing, nutrient recycling and species interactions, they influence carbon and nutrient cycling, ecosystem productivity, fisheries and aquaculture. Their biology is also highly dynamic: many protists alternate between growth, reproductive, resistant or dispersal stages, and can rapidly shift their physiology in response to temperature, nutrients, pollutants, pathogens and other environmental cues. These cellular transitions are ecologically important because they can precede visible changes in community composition, including harmful algal blooms, infection events or the destabilisation of symbiotic systems. However, only a small fraction of protist diversity can be maintained in laboratory culture, and important life-cycle transitions are often triggered by environmental conditions that are difficult to reproduce experimentally. Studying individual cells directly in natural samples is therefore essential to understand the true diversity, activity and ecological roles of microbial eukaryotes.

Research Gap:

Current biomonitoring approaches rely mainly on DNA metabarcoding and metagenomics. These methods have transformed biodiversity surveys by revealing which taxa are present, but they often provide uncertain abundance estimates, may detect DNA from dead or damaged cells, and cannot resolve the physiological states of individual organisms. Bulk metatranscriptomics adds information on gene activity, yet signals are dominated by abundant taxa and are difficult to assign confidently to specific organisms. As a result, existing surveys offer only limited access to processes such as growth, quiescence, reproduction, stress, infection, predation, parasitism and symbiosis. Single-cell transcriptomics can overcome this limitation by linking organism identity to gene expression in the same cell, while also revealing cell-to-cell heterogeneity and potential biological interactions. Its use in complex environmental communities nevertheless remains technically challenging because protists differ greatly in cell-wall composition, size and RNA content, and most environmental species lack reference genomes or transcriptomes. This PhD will address these barriers by combining scalable plate-based single-cell RNA sequencing, long-read technologies, image-based cell sorting and computational approaches for de novo transcriptome reconstruction and taxonomic assignment. The resulting framework will connect molecular profiles with cell morphology, functional state and ecological interactions, and will be evaluated using contrasting marine and freshwater communities.

Relevance to resource stress and climate change (Water-Land-Energy Nexus):

The project primarily addresses the Water component of the nexus, with direct links to Food and Climate. Aquatic microbial communities respond rapidly to warming, altered nutrient inputs, pollution and hydrological change, making them sensitive indicators of ecosystem condition. By identifying which organisms are active, how their physiological states change and which interactions are being established or disrupted, the project aims to detect functional responses that may occur before large shifts in species composition or visible ecosystem damage. Such information could improve the interpretation of harmful algal blooms, changes in microbial food webs, pathogen or parasite dynamics, and stress in ecosystems that support fisheries and aquaculture. In the longer term, organism-resolved functional indicators could complement conventional biodiversity monitoring and help environmental agencies, ecological observatories and aquatic-sector stakeholders evaluate ecosystem health, prioritise management actions and assess resilience to climate-related disturbances. The cross-border co-supervision will connect advanced molecular and computational development at CRG with expertise in aquatic microbial ecology and environmental observation at the University of Montpellier, ensuring that the methodology is tested in ecologically relevant Mediterranean contexts.

Objectives:

• Develop and benchmark robust long-read single-cell RNA-sequencing workflows for diverse environmental microbial eukaryotes.
• Build a reference-free computational workflow to group cells, reconstruct transcriptomes and assign organism identity without requiring complete reference genomes.
• Identify organism-specific functional states, including growth, stress, reproduction and infection.
• Detect candidate ecological interactions, including symbiosis, predation and parasitism, from single-cell molecular signatures.
• Apply the approach to selected marine and freshwater samples and assess its value for ecosystem monitoring and climate-resilience research.

Expected Results:

• A validated experimental workflow for high-throughput single-cell transcriptomics of mixed microbial eukaryote communities.
• A reproducible analysis pipeline for taxonomic assignment, de novo transcriptome reconstruction, cellular-state analysis and interaction discovery.
• Organism-resolved datasets from contrasting aquatic environments, integrated with relevant environmental information.
• New insight into how microbial activity and interactions vary across environmental conditions and disturbances.
• Candidate functional indicators that could inform future biomonitoring programmes and applied use cases in environmental management or aquaculture.

Work plan:

• **WP1, method development** at CRG: optimise cell isolation, lysis, reverse transcription and long-read single-cell transcriptomics using representative protists and defined mixed communities.

• **WP2, computational development** at CRG: implement modules for cell grouping, de novo transcriptome reconstruction, taxonomic profiling, functional-state analysis and candidate interaction detection.
• **WP3, environmental sampling** with the co-host: design and conduct field-based applications in Mediterranean aquatic systems, linking single-cell data to ecological gradients and complementary monitoring information.
• **WP4, joint ecological interpretation**: compare taxa, states and interactions across samples, prioritise potential stress indicators and validate key findings with complementary evidence where feasible.
• **WP5, training and translation:** complete the co-host mobility period and non-academic secondment, engage with potential users such as monitoring agencies or aquaculture stakeholders, and disseminate methods and results.

References of both supervisors:

1. Sebé-Pedrós, A. et al. The Biodiversity Cell Atlas: mapping the tree of life at cellular resolution. Nature 645, 877–885 (2025).
2. Levy, S. et al. The evolution of facultative symbiosis in stony corals. Nature 648, 368–376 (2025).
3. Grau-Bové, X. et al. Cell-resolved transcriptional responses during heat-induced coral bleaching and recovery. bioRxiv 2026.07.18.739195 (2026) doi:10.64898/2026.07.18.739195.
4. Levy, S. et al. A stony coral cell atlas illuminates the molecular and cellular basis of coral symbiosis, calcification, and immunity. Cell 184, 2973-2987.e18 (2021).
5. Ku, C. & Sebé-Pedrós, A. Using single-cell transcriptomics to understand functional states and interactions in microbial eukaryotes. Philosophical Transactions of the Royal Society B: Biological Sciences 374, 20190098 (2019).

Required Skills and Competences:

• Strong motivation to work at the interface of molecular biology, bioinformatics and aquatic ecology.
• Experience in molecular biology, RNA methods, genomics or single-cell approaches is desirable.
• Interest in computational analysis; experience with R, Python, Linux or workflow tools is an advantage.
• Ability and willingness to participate in environmental sampling, interdisciplinary collaboration and international mobility.
• Good written and spoken English, scientific curiosity, independence and teamwork skills.

Master's degree(s) required or equivalent(s):

Molecular biology; genetics or genomics; bioinformatics or computational biology; microbiology; marine biology; aquatic ecology; environmental sciences; evolutionary biology; biotechnology; biochemistry; systems biology; biodiversity or ecology.

Co-supervision partnership framework

Co-supervision (2 supervisors): Yes
Double degree PhD (France / Spain) where applicable and approved by the relevant institutions: Yes

Indicative mobility arrangements

Hosting institution: Centre for Genomic Regulation (CRG), 36 months
Co-hosting institution secondment: University of Montpellier / MARBEC, 9 months
Non-Academic secondment: 3 months (planned, AtrandiBio).

Work conditions

Duration: 48 months
Indicative start date : September/ October 2027

Indicative gross salary:

~ €2,450/month + Statutory end-of-contract compensation in accordance with Spanish legislation estimated at ~ €80/months accrued during the contract and paid at the end of the contract. Estimated total annual gross salary: 30.600€

Eligible fellows with one or more dependent children may receive an additional family allowance of €50 per month.

Trainings:

Single-cell transcriptomics; long-read sequencing; bioinformatics and reproducible workflows; aquatic microbial ecology; field sampling; research ethics; open science; innovation, entrepreneurship and project management.

Mobility required : yes
Non-academic secondment : yes
Double degree / Cotutelle possible: Yes, subject to approval by the relevant institutions and doctoral schools
Doctoral tuition fees and Visa fees: fully covered by TERRA-MED program
Social security: Full employer contributions covered by the recruiting entity.

Host institution	Co-host institution
The doctoral candidate will join the international and interdisciplinary research environment of the CRG in Barcelona. The Sebe-Pedros Lab offers expertise in single-cell genomics and non-model eukaryotes, supported by established workflows and access to liquid-handling robotics, advanced flow cytometry and image-based cell sorting, long-read sequencing, CRG genomics and bioinformatics support, and high-performance computing.	The University of Montpellier / MARBEC will provide complementary training in aquatic microbial ecology, environmental observation, field sampling and ecological interpretation. The mobility period will connect molecular method development with real Mediterranean ecosystems, environmental gradients and monitoring contexts, while broadening the candidate's international and interdisciplinary network.

Eligibility conditions

***Horizon Europe MSCA Mobility Rule*:** Researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of the host organization (France or Spain depending on the employing institution) for more than 12 months in the 36 months immediately before the recruitment date – unless as part of a compulsory national service or a procedure for obtaining refugee status under the Geneva Convention.

***Horizon Europe MSCA Eligibility Criteria*:** Applicants must be eligible for enrolment in a doctoral programme at the employer institution and must not already hold a doctoral degree at the date of recruitment.

Applicants who do not fulfill the Mobility Rule and the Eligibility Criteria WILL NOT be considered for the research position.

***Language requirements*:** Applicants must demonstrate sufficient proficiency (B2) in English to successfully conduct doctoral research and participate in the TERRA-MED training programme.

For more information on this call for candidates see our website here and the guide for applicants here.

APPLY HERE BY Decembre 31st 2026

Administrative Contact

TERRA-MED Programme Office (only for general administrative questions and redress demands. Any research-related question must be addressed to the supervisors by email, see second page)
Email: terramed@euroregio-epm.eu